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# Destruction of the eastern North China Craton in a backarc setting: Evidence from crustal deformation kinematics

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ABSTRACT

The eastern North China Craton (NCC) west of the Pacific Ocean has a long history of rifting from Early Cretaceous to the end of Paleogene when the craton experienced destruction and significant thinning of the lithosphere. The cause and geotectonic environment for this destruction remain controversial. We use a set of field observation including basin patterns, fault geometry and kinematics, fault plane slip data, dike distribution, and fabric data from metamorphic core complexes to determine the kinematic evolution of the deformation in the eastern NCC during this period. We show that the principal extension direction in the eastern NCC evolved from WNW–ESE in the earliest-middle Early Cretaceous, via NW–SE in the latest Early Cretaceous, to nearly N–S in the Late Cretaceous–Paleogene. The movement history, from Late Mesozoic to Early Cenozoic, of the oceanic plates in the Pacific Ocean with respect to the eastern NCC is available from previous studies. The Izanagi Plate first subducted nearly orthogonally (WNW-wards) during earliest-middle Early Cretaceous time, and then moved obliquely (NNW-wards) in the latest Early Cretaceous while the relaying Pacific Plate moved generally northwards from the Late Cretaceous to Paleogene. Both the movement direction of oceanic plates and the principal extension direction of the continental deformation rotated clockwise. We suggest that such a correlation can be explained by the eastern NCC being in a backarc setting in the Cretaceous–Paleogene period. The results support the backarc extensional model for the destruction and significant lithospheric thinning of the eastern NCC.

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## 1. Introduction

It is now well documented that the part of the North China Craton (NCC) east of the NNE-trending Taihang Mountains has undergone some 100 km reduction in lithosphere thickness since the Mesozoic (Zheng et al., 2001; Gao et al., 2002; Wu et al., 2005; Zhang, 2005; Menzies et al., 2007; Xu, 2007; Zhu et al., 2010a). This phenomenon has been generally referred to as the craton destruction of the NCC, hereafter referred to as the Craton Destruction. The Craton Destruction is associated with widespread crustal extension (e.g. Wu et al., 2005; Menzies et al., 2007; Zhai et al., 2007; Zhu et al., 2010a). The geodynamic cause and deformation settings for the Craton Destruction remain unclear. Proposed mechanisms include: 1) extension following the continent–continent collision either between the NCC and the South China Block along the southern margin of the craton (e.g. Gao et al., 2002; Zhang, 2005) or between the NCC and the Siberian–Mongolian blocks at the north (e.g. Zhai et al., 2007), 2) plume activity underneath the NCC (Wilde et al., 2003), and 3) backarc extension related to oceanic plate subduction in the Pacific Ocean (Wu et al., 2005; Deng et al., 2007; Sun et al., 2007; Zhao et al., 2007; Zhao and Ohtani, 2009; Zheng and Wu, 2009; Zhu et al., 2010a).

There is abundant evidence that the whole East China continental margin was in a rifting environment from Early Cretaceous to the end of Paleogene as indicated by widespread terrestrial rift basins (Ren et al., 2002; Liu et al., 2003; Zhang et al., 2003; Meng et al., 2007; Mercier et al., 2007; Zhu et al., 2008, 2010a). However, such extension is obviously weakening in the NCC west of the Taihang Mountains. While these observations support the backarc extension model, no arc magmatism has been identified in the eastern NCC. On the other hand, structural data supporting it are also scarce. Although Zhang et al. (2003), from fault plane slip data, proposed that the principal extension direction in the eastern NCC changed from N–S in the earliest Early Cretaceous (140–120 Ma), to WNW–ESE in the latest Early Cretaceous (120–100 Ma), and to N–S in the Late Cretaceous (85–65 Ma), and Mercier et al. (2007), from a similar analysis, argued that the extension evolved from NW–SE during the earliest Early Cretaceous (135–130 Ma), to NE–SW during the middle–late Early Cretaceous (127–105 Ma), and to WNW–ESE during the Late Cretaceous–Paleogene, neither paper discussed what caused the change.

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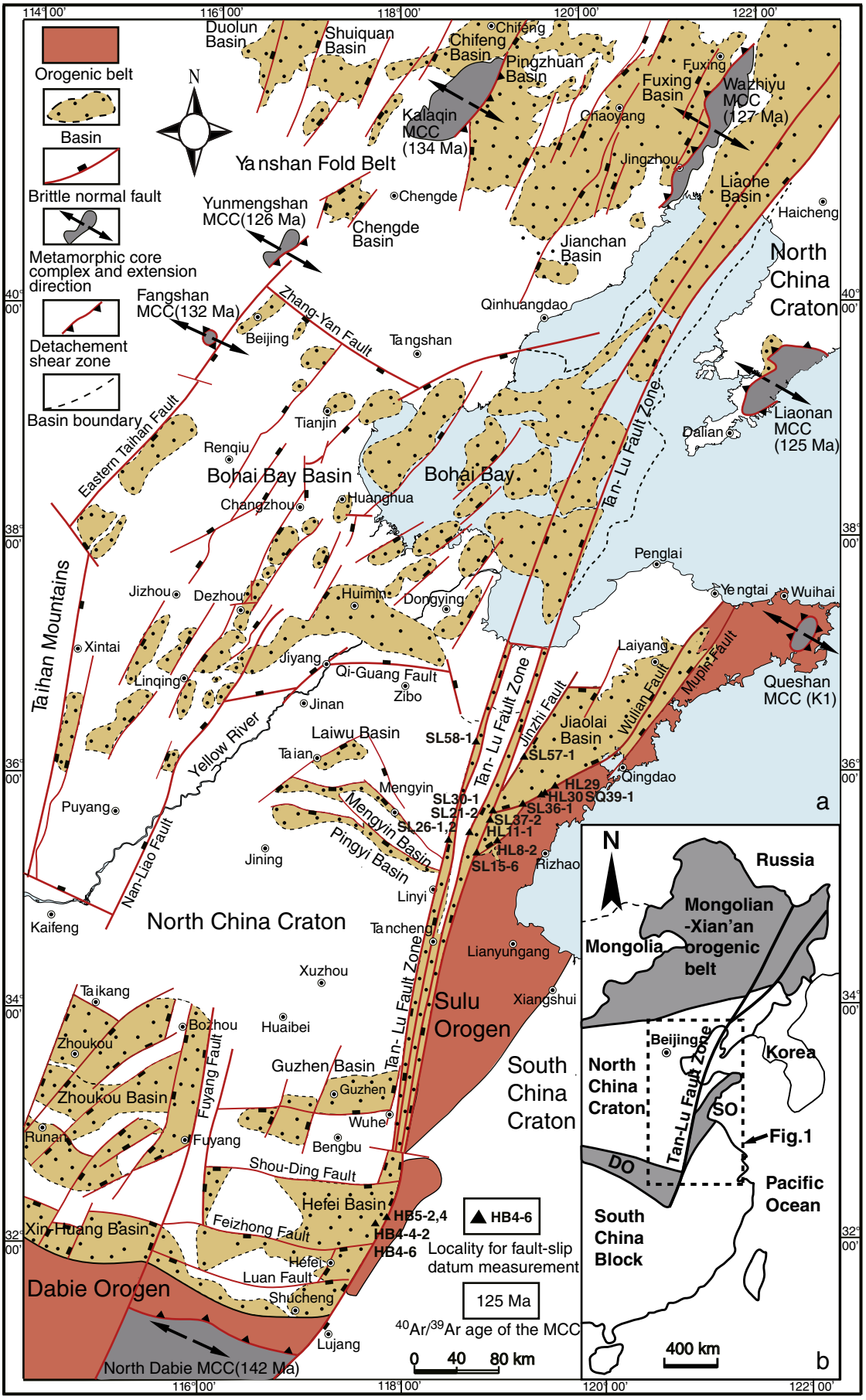
Orogenic belt
Basin
Brittle normal fault
Metamorphic core complex and extension direction
Detachement shear zone
Basin boundary
N
Duolun Basin
Shuiquan Basin
Chifeng Basin
Pingzhuan Basin
Kalaqin MCC (134 Ma)
Yanshan Fold Belt
Yunmengshan MCC(126 Ma)
Chengde Basin
Fangshan MCC(132 Ma)
Zhang-Yan Fault
Beijing
Tangshan
Tianjin
Eastern Taihan Fault
Renqiu
Bohai Bay Basin
Bohai Bay
Changzhou
Huanghua
Taihan Mountains
Jizhou
Dezhou
Huimin
Dongying
Xintai
Jiyang
Linqing
Qi-Guang Fault
Zibo
Jinan
Yellow River
Laiwu Basin
Taian
Mengyin
Mengyin Basin
Pingyi Basin
Puyang
Nan-Liao Fault
Jining
Linyi
Kaifeng
North China Craton
Tancheng
Tan- Lu Fault Zone
Xuzhou
Taikang
Bozhou
Huaibei
Zhoukou
Zhoukou Basin
Fuyang Fault
Guzhen Basin
Guzhen
Wuhe
Runan
Fuyang
Bengbu
Shou-Ding Fault
Hefei Basin
Xin-Huang Basin
Feizhong Fault
Hefei
Luan Fault
Dabie Orogen
Shucheng
Lujang
North Dabie MCC(142 Ma)
Sulu Orogen
South China Craton
Lianyungang
Xiangshui
Jianchan Basin
Qinhuangdao
Chaoyang
Fuxing Basin
Fuxing
Wazhiyu MCC (127 Ma)
Jingzhou
Liaohe Basin
Haicheng
North China Craton
Liaonan MCC (125 Ma)
Dalian
Penglai
Yengtai
Wuihai
Laiyang
Jiaolai Basin
Jinzhi Fault
Wilian Fault
Mupin Fault
Queshan MCC (K1)
Qingdao
Rizhao
SL58-1
SL57-1
HL29
HL30
SQ39-1
SL30-1
SL21-2
SL36-1
SL37-2
SL26-1,2
HL11-1
HL8-2
SL15-6
HB5-2,4
HB4-4-2
HB4-6
HB4-6
Locality for fault-slip datum measurement
125 Ma
40Ar/39Ar age of the MCC
0 40 80 km
a
N
Russia
Mongolian -Xian'an orogenic belt
Mongolia
Beijing
Korea
North China Craton
Tan-Lu Fault Zone
SO
Fig.1
DO
Pacific Ocean
South China Block
400 km
b

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